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(54) SINGLE PACKER WITH A SEALING LAYER SHAPE ENHANCED FOR FLUID PERFORMANCE

EINZELVERPACKER MIT EINER FÜR FLÜSSIGKEITSLEISTUNG FORMVERBESSERTEN VERSIEGELUNGSSCHICHT

GARNITURE UNIQUE PRÉSENTANT UNE FORME DE COUCHE D'ÉTANCHÉITÉ AMÉLIORÉE VIS-À-VIS DES PERFORMANCES DE FLUIDE

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Description

FIELD OF THE INVENTION

[0001] The present disclosure generally relates to evaluation of a subterranean formation. More specifically, the present disclosure relates to a packer tool with a sealing layer.

BACKGROUND INFORMATION

[0002] For oil and gas exploration, information about subsurface formations that are penetrated by a wellbore is necessary. Measurements are essential to predicting production capacity and production lifetime of a subsurface formation. Collection and sampling of underground fluids contained in subterranean formations are well known. Moreover, testing of a formation may provide valuable information regarding the properties of the formation and/or the hydrocarbons associated therewith. In the petroleum exploration and recovery industries, for example, samples of formation fluids are collected and analyzed for various purposes, such as to determine the existence, composition and producibility of subterranean hydrocarbon fluid reservoirs. This aspect of the exploration and recovery process is crucial to develop exploitation strategies and impacts significant financial expenditures and savings.

[0003] A variety of packers are used in wellbores to isolate specific wellbore regions. A packer is delivered downhole on a tubing string, and a packer sealing element is expanded against the surrounding wellbore wall to isolate a region of the wellbore. The sealing layer of the sealing element is typically a uniformly-surface, cylindrical layer of rubber/elastomer. Often, two or more packers may be used to isolate several regions in a variety of well related applications, including production applications, service applications and testing applications.

[0004] Isolating a particular section of a wellbore typically involves deploying a dual packer system. Deploying a dual packer system is more involved than deploying a single packer since a greater likelihood that one packer may fail exists. Therefore, a single packer is desired which may be deployed in a formation to isolate a portion of the wellbore.

[0005] US7874356 discloses a technique which involves collecting formation fluids through a single packer having a plurality of sample collectors disposed along an expandable packer element. An anti-expansion device also is deployed along the expandable packer element to limit expansion in localized regions. Limiting the expansion can provide additional space or an increased production surface that facilitates collection of samples.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006]

FIGS. 1 and 2 generally illustrate a typical packer system of the prior art.

FIG. 3 generally illustrates an example of a packer with expansion rings in accordance with one or more aspects of the present disclosure.

FIG. 4 shows an example of a well system in which one or more embodiments of the present disclosure may be used.

FIG. 5 generally illustrates an example of a packer with a composite outer layer in accordance with one or more aspects of the present disclosure.

FIG. 6 generally illustrates an example of a packer with an irregular outer layer in accordance with one or more aspects of the present disclosure.

DETAILED DESCRIPTION

[0007] Certain examples are shown in the above-identified figures and described in detail below. In describing these examples, like or identical reference numbers are used to identify common or similar elements. The figures are not necessarily to scale and certain features and certain views of the figures may be shown exaggerated in scale or in schematic for clarity and/or conciseness.

[0008] Aspects generally relate to a system and method for collecting formation fluids using a single packer with rings and/or an irregular sealing layer. Use of the single packer with rings enables larger expansion ratios and higher drawdown pressure differentials. Additionally, the single packer configuration reduces the stresses otherwise incurred by the packer tool mandrel due to the differential pressures. In at least some embodiments, the single packer may support the formation in hydrocarbon-yielding zone at which formation fluids are collected. The single packer configuration facilitates relatively large amplitude draw-downs even in weak, unconsolidated formations.

[0009] The single packer expands across an expansion zone, and formation fluids can be collected from the middle of the expansion zone, *i.e*. between axial ends of the single packer. The formation fluid is collected and directed along flow lines, *e.g*. along flow tubes, from the one or more drains. For example, separate drains can be disposed along the length of the packer to establish collection intervals or zones that enable focused sampling at a plurality of collecting intervals, *e.g*. two or three collecting intervals. Separate bowlines can be connected to different drains, *e.g*. sampling drains and guard drains, to enable the collection of unique formation fluid samples.

[0010] The single packer provides a simplified packer structure that facilitates, for example, focused sampling. The outer flexible layer may also be used to contain drains, such as groups of drains in which a middle group has sampling drains and two axially outer groups have

guard drains. The drains may be coupled to the bowlines in a manner that facilitates expansion and contraction of the single packer.

[0011] Referring now to FIG. 1, one embodiment of a typical packer assembly **20** of the prior art is illustrated as deployed in a wellbore **22**. In this embodiment, the packer assembly **20** has an inflatable single packer **24** having an outer flexible skin **26** formed of expandable material, *e.g*. a rubber material, which allows for inflation of the packer **24**. The outer flexible skin 26 is mounted around a packer mandrel **28** and has openings for receiving drains **30**. By way of example, the drains **30** may have one or more sampling drains **32** positioned between guard drains **34**. The drains **30** are connected to corresponding flow lines **36** for transferring fluid received through the corresponding drains **30**. The flow lines **36** connected to the guard drains **34** may be separated from the flow lines **36** connected to the sample drains **32**.

[0012] The packer **24** is a single packer having an outer layer formed of an outer flexible skin **26** made from an elastic material, *e.g*. rubber. The outer flexible skin **26** is expandable in a wellbore to seal with a surrounding wellbore wall. The single packer **24** has an inner inflatable bladder **148** disposed within the outer flexible skin **26**. By way of example, the inner bladder **148** may be selectively expanded by introducing fluid via the interior packer mandrel **28**. Additionally, the packer **24** has a pair of mechanical fittings **150** that may have fluid collectors **152** coupled with the flow lines **36**. The mechanical fittings **150** are mounted around the inner mandrel **28** and engaged with axial ends of the outer flexible skin **26**.

[0013] Referring to FIG. 1, the outer flexible skin **26** has openings for receiving the drains **30** through which formation fluid is collected when the outer flexible skin **26** is expanded against a surrounding wellbore wall. The drains **30** may be embedded radially into the outer flexible skin **26**. A plurality of the flow lines **36** may be operatively coupled with the drains **30** for directing the collected formation fluid in an axial direction to one or both of the mechanical fittings **150.** In an embodiment, the flow lines **36** are in the form of tubes, and the tubes are connected to the guard drains **34** and the sample drains **32** disposed between the guard drains **34**. The tubes maintain separation between the fluids flowing into the guard drains **34** and the sample drains **32**, respectively.

[0014] As illustrated in FIG. 2, the flow lines **36** may be tubes/conduits oriented generally axially along the packer **24**. The flow lines **36** extend through the axial ends of the outer flexible skin **26**. By way of example, the flow line **36** may be at least partially embedded in the flexible material of the outer flexible skin **26**. Consequently, the portions of the flow lines **36** extending along the outer flexible skin **26** move radially outward and radially inward during expansion and contraction of the packer **24**. One or more mechanical fittings **150** may have collector portions **152** coupled with a plurality of movable members **154**. The movable members **154** are pivotably coupled to each of the collector portions **152** via pivot links for pivotable motion about an axis generally parallel with the packer axis. At least some of the movable members **154** are designed as tubes to transfer fluid received from the flow lines **36**, extending along outer flexible skin **26**, to collector portions **152**. From the collector portions **152**, the collected fluids may be transferred/directed to desired collection/testing locations. The pivotable motion of the movable members **154** enable transition of the packer **24** between a contracted state and an expanded state. The movable members **154** may be designed generally as S-shaped members pivotably connected between flow lines in the outer flexible skin **26** and the collector portions **152**.

[0015] As described above, the packer assembly **20** may be constructed in a variety of configurations for use in many environments and applications. The packer **24** may be constructed from different types of materials and components for collection of formation fluids from single or multiple intervals within a single expansion zone. The flexibility of the outer flexible skin **26** enables use of the packer **24** in many well environments. Furthermore, the various packer components can be constructed from a variety of materials and in a variety of configurations as desired for specific applications and environments.

[0016] FIG. 3 illustrates a packer **100** with expansion rings **40**, **42** in accordance with one or more aspects of the present disclosure. As illustrated, the rings **40**, **42** may be formed of thick portions of rubber. The rings **40**, **42** may be composed of the same material used to form the outer flexible skin **126**. Depending on the application, the packer **100** may have one or more of the rings **40**, **42**. In the illustrated example, the packer **100** has two of the rings **40** to isolate the sample drains **132**. Further, the packer **100** has two of the rings **42** to isolate the guard drains **134**.

[0017] The rings **40**, **42** may isolate different portions of the wellbore during testing. Thus, the rings **40**, **42** may be used for focused sampling of specific portions of a wellbore. That is, the packer **100** may be disposed in a wellbore at any depth to test a particular section of that wellbore. Moreover, the rings **40**, **42** may enable sampling across a larger surface area. For example, the rings **40**, **42** may isolate an entire section of the wellbore. Fluid drawn into the sample drains **32** may be extracted from the entire isolated portion. Thus, the rings **40**, **42** enable any size or type of drain to be used. For example, if a small drain is used, a sufficient amount of fluid may be sampled due to the isolation of an entire section of the wellbore using the rings **40**, **42**.

[0018] Further, the rings **40**, **42** may improve fluid sampling in tight formations. The rings **40**, **42** may create an air-tight seal in the isolated portion of the wellbore. Thus, the packer **100** may create a larger pressure differential to draw fluid from the tight formation. The outer rings **42** isolating the guard drains **134** may focus contaminated fluid into the guard drains **134**. Thus, the segregation of non-contaminated fluid and contaminated fluid may be more effectively implemented.

[0019] The rings **40**, **42** may be provided with the packer **100** and/or may be retrofitted to the packer **100.** The rings **40**, **42** may be installed and/or removed depending on the formation and/or the desired sampling method. The rings **40**, **42** may be permanently affixed to the packer **100** by welding, fasteners, and/or cement. The placement of the rings **40**, **42** may also be customized depending on a desired application. For example, in a formation with increased contaminants in the fluid, a larger guard drain section may be desired.

[0020] In the illustrated embodiment, the packer **100** has four rings: two inner rings **40** and two outer rings **42**. The rings **40**, **42** define three contiguous sections **51**, **52**, **53**. The first section **51** and the third section **53** may contain guard drains **134**. The second section **52** may contain sample drains **132**.

[0021] FIG. 4 shows an example of a well system **20** in which one or more embodiments of the present disclosure may be used. In this example, the well system **20** has a rig **22** used to deliver a tool **21** downhole into a wellbore **19**. The rig **22** is positioned at a surface location **18**, such as a land surface location, from which the wellbore **19** is drilled. Depending on the specific application, the tool **21** may have various components and/or assemblies used in a variety of well related operations. One of the components may be a packer assembly **100** according to one or more embodiments of the present disclosure. As illustrated, the packer assembly **100** is delivered downhole via a well string **31**, *e.g.* a tubing string, to a desired location in the wellbore **19**. After lowering the well string **31** into the wellbore **19**, the packer assembly **100** is inflated until the outer sealing layer **126** abuts a wall **17** of the wellbore **19**. The rings **40**, **42** isolate portions of the wellbore **19**. Sampling of formation fluid **23** is carried out via the drains **132**, **134** of the packer assembly **100**.

[0022] When deployed and expanded in a wellbore **19**, the three sections **51**, **52**, **53** may enclose three corresponding sections of the wellbore. The rings **40**, **42** create a temporary seal between the packer **100** and walls **17** of the wellbore. A pressure differential may be initiated in the packer **100** to draw fluid from the formation **23** into the drains **132**, **134**.

[0023] FIG. 5 illustrates the packer **100** with an irregular sealing layer **45** in accordance with one or more embodiments. The irregular sealing layer **45** may form grooves in the rubber of the outer diameter of the packer **100**. The grooves **44** may create a leak path between the drains **32**, **34** of the packer **100**. Moreover, when used in embodiments of the packer **100** with the expansion rings **40**, **42**, the grooves **44** may guide sample fluid into the drains **132, 134** from a sealed portion of the wellbore **19**. Thus, in the embodiment with the expansion rings **40**, **42**, the grooves **44** effectively create one large sampling inlet between each pair of the rings **40**, **42**. The irregular sealing layer may be used in combination with or without the expansion rings **40**, **42**.

[0024] In practice, when the packer **100** is expanded to abut the walls **17** of the wellbore **19**, the outer diameter of the packer **100** is flush against the wall of the wellbore **19**. Without the grooves **44,** fluid may only be drawn into the drains **132**, **134** from that portion of the wall **17** that is directly abutted to the drain **132**, **134**. However, the grooves **44** create leak paths through which sample fluid may flow. The leak paths formed by the grooves **44** may carry fluid to one or more of the drains **132**, **134**.

[0025] In FIG. 6, the irregular sealing layer **45** may be a composite material **46** composed of technical fibers/textiles and/or plastic. The technical fibers may be a non-aesthetic textile material used to increase strength and provide certain properties depending on the application. Permeable technical fibers, such as geo-textiles, may be used in embodiments. The composite material **46** may be semi-permeable such that fluid may flow through the material, but solids may not flow through the material. Thus, the composite material **46** may prevent contamination of samples. The composite material **46** may also facilitate fluid flow when the outer diameter of the packer **100** is abutted to a formation wall **17**.

[0026] In the embodiments described above where a component is described as formed of rubber or comprising rubber, the rubber may include an oil resistant rubber, such as NBR (Nitrile Butadiene Rubber), HNBR (Hydrogenated Nitrile Butadiene Rubber) and/or FKM (Fluoroelastomers). In a specific example, the rubber may be a high percentage acrylonytrile HNBR rubber, such as an HNBR rubber having a percentage of acrylonytrile in the range of approximately 21% to approximately 49%. Components suitable for the rubbers described in this paragraph include, but are not limited to, the outer flexible skin **26** and the inflatable bladder **148**.

[0027] In one embodiment a system for collecting fluid in a wellbore is disclosed comprising an outer flexible skin having an outer diameter, a plurality of rings disposed around the outer diameter, a plurality of drains coupled to the outer flexible skin, and a mandrel positioned within the outer flexible skin. In another embodiment, a method is disclosed comprising deploying a packer assembly into a wellbore wherein the packer assembly inflates toward a wall of the wellbore and has an opening connected to a flow line for receiving fluid and two exterior rings extending around a circumference of the packer assembly; expanding the packer assembly such that the exterior rings abut the wall of the wellbore; isolating a section of the wellbore by creating a seal between the wellbore wall and the exterior rings and obtaining fluid through the opening. In still another embodiment, a sampling tool is disclosed comprising an outer sealing layer having irregularities, a plurality of drains coupled to the outer sealing layer, a flow line connected to an opening for moving the fluid into the packer assembly, and a mandrel positioned within the outer flexible skin.

[0028] Although exemplary systems and methods are described in language specific to structural features and/or methodological acts, the subject matter defined

in the appended claims is not necessarily limited to the specific features or acts described. Rather, the specific features and acts are disclosed as exemplary forms of implementing the claimed systems, methods, and structures. Accordingly, although only a few embodiments of the present invention have been described in detail above, those of ordinary skill in the art will readily appreciate that many modifications are possible without materially departing from the teachings above.

Claims

1. A system (100) for collecting fluid in a wellbore (19) comprising:

   an outer flexible skin (126) having an outer diameter;
   a plurality of rings (40, 42) disposed around the outer diameter;
   a plurality of drains (132, 134) coupled to the outer flexible skin (126) and configured to move towards and abut a wall (17) of the wellbore (19) when the outer flexible skin (126) expands; and
   a mandrel (28) positioned within the outer flexible skin (126).

2. The system of claim 1, wherein the rings (40, 42) and the outer flexible skin (126) are composed of a same material.

3. The system of claim 1, wherein the rings (40, 42) are disposed above and below one of the plurality of drains (132, 134).

4. The system of claim 1, further comprising grooves (44) on the outer flexible skin (126).

5. The system of claim 1, further comprising a semipermeable composite material on the outer flexible skin (126).

6. The system of claim 1, wherein four rings (50, 42) define three contiguous sections (51, 52, 53) about the outer diameter.

7. The system of claim 6, wherein a first section (51) and a third section (53) of the three contiguous sections (51, 52, 53) have guard drains (134), and a second section (52) of the three contiguous sections has a sample drain (132).

8. A method comprising:

   deploying a packer assembly (100) into a wellbore (19) wherein the packer assembly (100) inflates toward a wall (17) of the wellbore (19) and has an opening (132) connected to a flow line (36) for receiving fluid and two exterior rings (40) extending around a circumference of the packer assembly (100), wherein the opening (132) moves towards and abuts the wall (17) of the wellbore (19) when the packer assembly (100) inflates;
   expanding the packer assembly (100) such that the exterior rings (40) abut the wall (17) of the wellbore (19);
   isolating a section (52) of the wellbore (19) by creating a seal between the wellbore wall (17) and the exterior rings (40); and
   obtaining fluid through the opening (132).

9. The method of claim 8, wherein the fluid is obtained by creating a pressure differential.

10. The method of claim 8, wherein the packer assembly (100) has additional rings (42) defining sections (51, 53) with guard drains (134) above and below the opening (132).

11. The method of claim 8, wherein the packer assembly (100) has an irregular sealing layer (45), wherein the irregular sealing layer has grooves (44).

Patentansprüche

1. System (100) zum Sammeln von Fluid in einem Bohrloch (19), umfassend:

   eine flexible Außenhaut (126) mit einem Außendurchmesser;
   mehrere um den Außendurchmesser angeordnete Ringe (40, 42);
   mehrere an die flexible Außenhaut (126) gekuppelte Abflüsse (132, 134), die dazu ausgelegt sind, sich in Richtung auf eine Wand (17) des Bohrlochs (19) zu bewegen und an diese anzulegen, wenn die flexible Außenhaut (126) expandiert; und
   einen innerhalb der flexiblen Außenhaut (126) positionierten Dorn (28).

2. System nach Anspruch 1, wobei die Ringe (40, 42) und die flexible Außenhaut (126) aus dem gleichen Material sind.

3. System nach Anspruch 1, wobei die Ringe (40, 42) oberhalb und unterhalb eines der mehreren Abflüsse (132, 134) angeordnet sind.

4. System nach Anspruch 1, das ferner Rillen (44) auf der flexiblen Außenhaut (126) umfasst.

5. System nach Anspruch 1, das ferner ein semipermeables Verbundmaterial auf der flexiblen Außen-

haut (126) umfasst.

6. System nach Anspruch 1, wobei vier Ringe (50, 42) drei zusammenhängende Abschnitte (51, 52, 53) um den Außendurchmesser definieren.

7. System nach Anspruch 6, wobei ein erster Abschnitt (51) und ein dritter Abschnitt (53) der drei zusammenhängenden Abschnitte (51, 52, 53) Sicherheitsabflüsse (134) aufweisen, und ein zweiter Abschnitt (52) der drei zusammenhängenden Abschnitte einen Probenabfluss (132) aufweist.

8. Verfahren, umfassend:

In-Bereitstellung-Bringen einer Packeranordnung (100) in ein Bohrloch (19), wobei die Packeranordnung (100) sich auf eine Wand (17) des Bohrlochs (19) zu entfaltet und eine zum Empfangen von Fluid mit einer Strömungsleitung (36) verbundene Öffnung (132) und zwei sich um einen Umfang der Packeranordnung (100) erstreckende Außenringe (40) aufweist, wobei die Öffnung (132) sich in Richtung auf die Wand (17) des Bohrlochs (19) bewegt und an diese anlegt, wenn die Packeranordnung (100) expandiert;
Expandieren der Packeranordnung (100), so dass die Außenringe (40) sich an die Wand (17) der Bohrung (19) anlegen;
Isolieren eines Abschnitts (52) des Bohrlochs (19) durch Erzeugen einer Abdichtung zwischen der Bohrlochwand (17) und den Außenringen (40); und
Erhalten von Fluid durch die Öffnung (132).

9. Verfahren nach Anspruch 8, wobei das Fluid durch Erzeugen einer Druckdifferenz erhalten wird.

10. Verfahren nach Anspruch 8, wobei die Packeranordnung (100) zusätzliche Ringe (42) aufweist, die Abschnitte (51, 53) mit Sicherheitsabflüssen (134) oberhalb und unterhalb der Öffnung (132) definieren.

11. Verfahren nach Anspruch 8, wobei die Packeranordnung (100) eine unregelmäßige Abdichtungsschicht (45) aufweist, wobei die unregelmäßige Abdichtungsschicht Rillen (44) aufweist.

Revendications

1. Un système (100) de collecte des fluides dans un trou de forage (19) comprenant :

une peau souple extérieure (126) ayant un diamètre extérieur ;
une pluralité de bagues (40, 42) disposées autour du diamètre extérieur ;
une pluralité de drains (132, 134) couplés à la peau souple extérieure (126) et configurés de façon à avancer et venir buter contre une paroi (17) du trou de forage (19) lors de l'expansion de la peau souple extérieure ;
un mandrin (28) positionné à l'intérieur de la peau souple extérieure (126).

2. Le système selon la revendication 1, dans lequel les bagues (40, 42) et la peau souple extérieure (126) sont faites du même matériau.

3. Le système selon la revendication 1, dans lequel les bagues (40, 42) sont disposées au-dessus et au-dessous d'un de la pluralité de drains (132, 134).

4. Le système selon la revendication 1, comprenant en outre des rainures (44) sur la peau souple extérieure (126).

5. Le système selon la revendication 1, comprenant en outre un matériau composite semi-perméable sur la peau souple extérieure (126).

6. Le système selon la revendication 1, dans lequel quatre bagues (50,42) définissent trois sections contiguës (51, 52, 53) autour du diamètre extérieur.

7. Le système selon la revendication 6, dans lequel une première section (51) et une troisième section (53) des trois sections contiguës (51, 52, 53) ont des drains de garde (134), et une seconde section (52) des trois sections contiguës a un drain d'échantillonnage (132).

8. Un procédé consistant à :

déployer une garniture d'étanchéité (100) dans un trou de forage (19), dans lequel la garniture d'étanchéité (100) gonfle vers une paroi (17) du trou de forage (19) et a une ouverture (132) raccordée à une conduite d'écoulement (36) permettant de recevoir les fluides et deux bagues extérieures (40) s'étendant autour d'une périphérie de la garniture d'étanchéité (100), dans lequel l'ouverture (132) avance et vient buter contre la paroi (17) du trou de forage (19) quand la garniture d'étanchéité (100) gonfle ;
causer l'expansion de la garniture d'étanchéité (100) de façon à ce que les bagues extérieures (40) buttent contre la paroi (17) du trou de forage (19) ;
isoler une section (52) du trou de forage (19) en créant un joint d'étanchéité entre la paroi du trou de forage (17) et les bagues extérieures (40) ; et
obtenir les fluides à travers l'ouverture (132).

9. Le procédé selon la revendication 8, dans lequel le fluide est obtenu en créant une pression différentielle.

10. Le procédé selon la revendication 8, dans lequel la garniture d'étanchéité (100) a des bagues supplémentaires (42) définissant des sections (51, 53) dotées de drains de garde (134) au-dessus et au-dessous de l'ouverture (132).

11. Le procédé selon la revendication 8, dans lequel la garniture d'étanchéité (100) a une couche d'étanchéité irrégulière (45), la couche d'étanchéité irrégulière étant dotée de rainures (44).

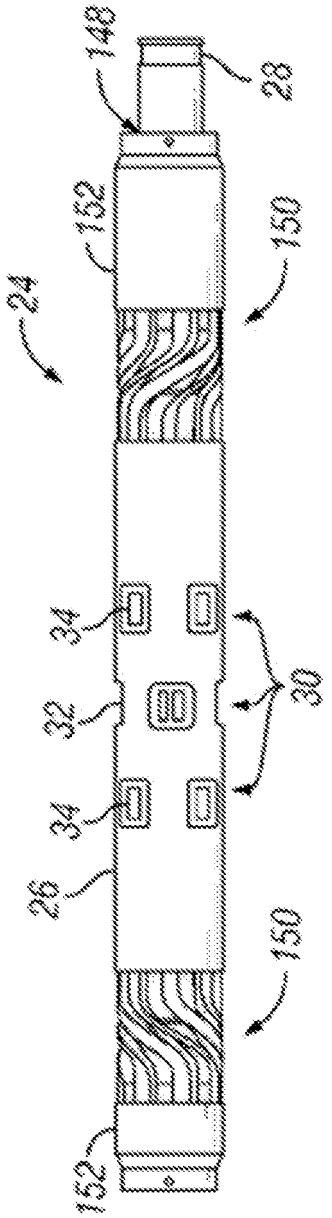

FIG. 1 Prior Art

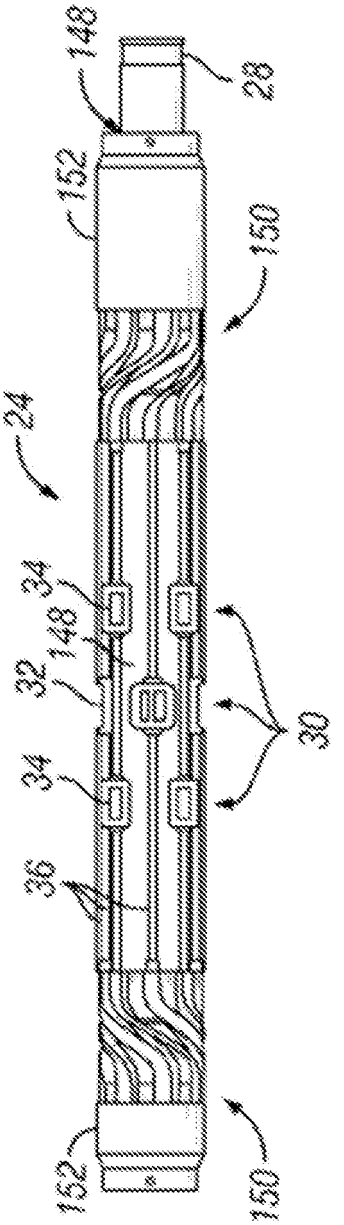

FIG. 2 Prior Art

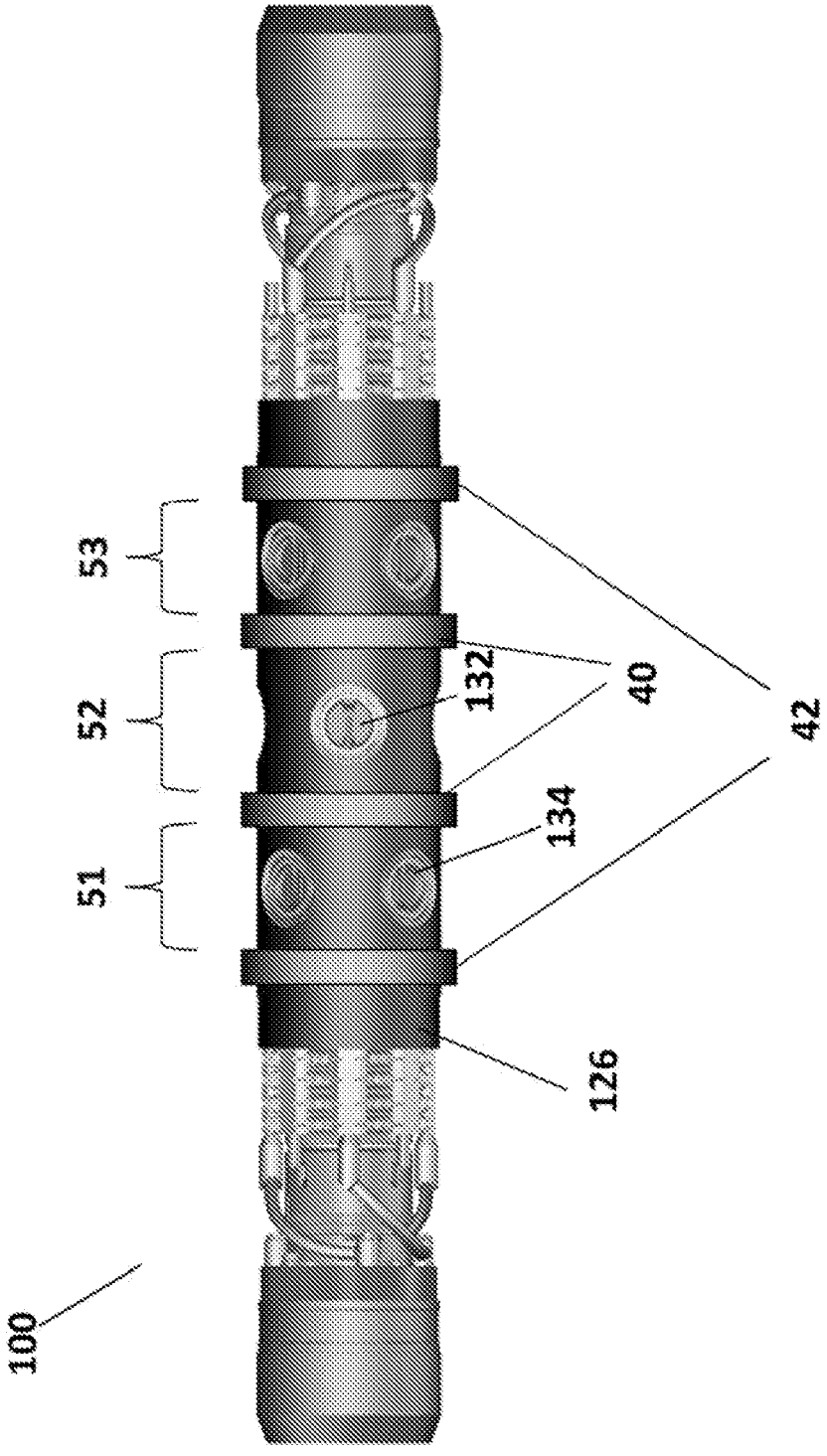

FIG. 3

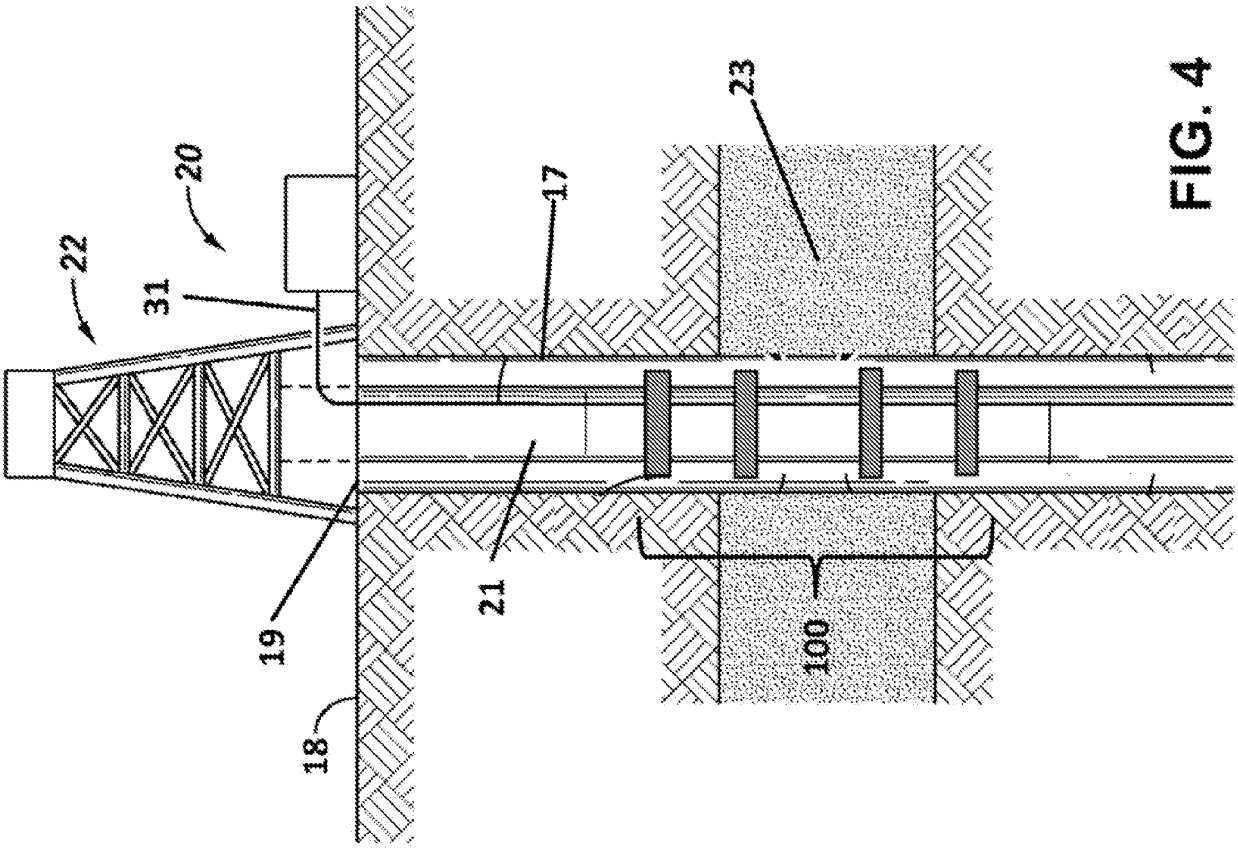

FIG. 4

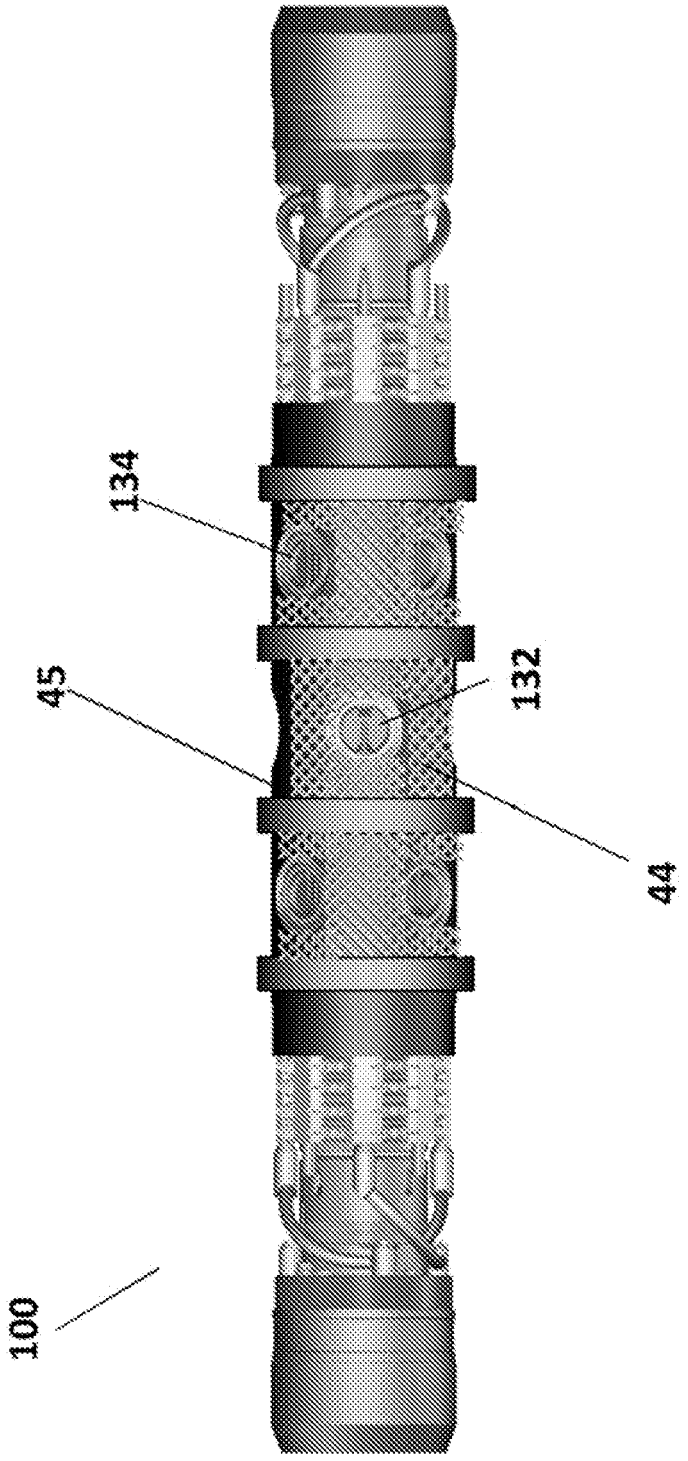

FIG. 5

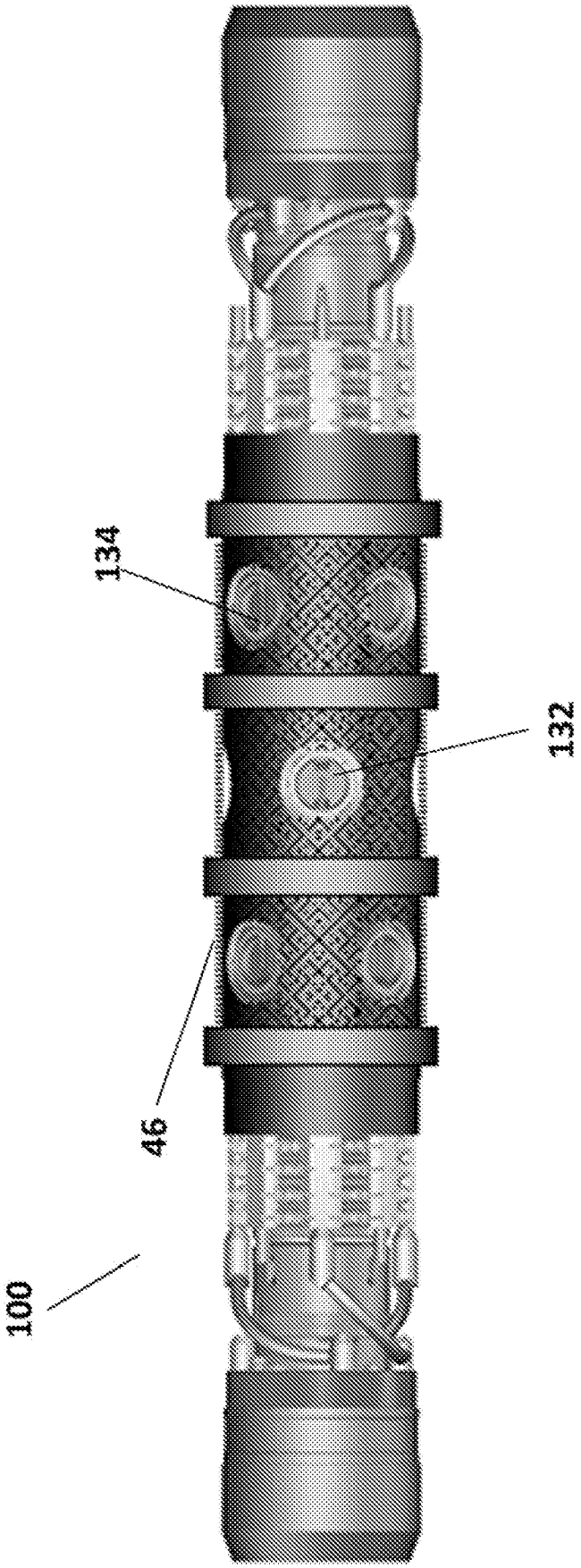

FIG. 6

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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